



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

DN 3535-35-00 /
51006-2

In re application of:
Hunt et al.

Serial No.: 09/733,815

Filed: March 31, 1999

: Group Art Unit: 2831*

For: FORMATION OF THIN FILM CAPACITORS : Examiner: E. Thomas*

**Examiner Thomas of Group 2831, in a telephone conversation with Wayne E. Nacker, Reg. 29,571, attorney for applicant, said he would take this case as the claims being presented herewith are substantially the same as those discussed in an interview with Andrew T. Hunt (inventor) and Wayne E. Nacker in Application No. 09/283,100 on 16 August 2001.*

SECOND PRELIMINARY AMENDMENT

Assistant Commissioner of Patent and Trademarks
US Patent and Trademark Office
Washington, DC 20231

Prior to examination, please cancel Claims 1-25 as currently on file and replace them with new Claims 37- 68, which are set forth in the Attachment.

REMARKS

Substitute independent Claims 37, 48, and 62 presented above, were discussed in relation to a "Draft" Amendment discussed in an interview 16 August 2001 between Examiner Thomas, Dean Reichard (SPE), Andrew T. Hunt (first named inventor), and Wayne E. Nacker, attorney for applicants in respect to U.S. application 09/283,100. Examiners Thomas and Reichard found the claims, as (proposed) amended, to be free of the prior art, specifically, U.S. Patent 5,027,253 to Lauffer et al., on which the final rejection of the previously submitted claims was based.

However, both Examiners Thomas and Reichard felt that further searching would be necessary in view of the (proposed) new limitations. The Examiners took the position that further searching could not be done in the instant application; thus, Examiner Reichard suggested that applicants file a Request for Continuing Examination (RCE).

However, as other claims had previously been indicated to be allowable in the 09/283,100 application, applicants, as discussed between Wayne E. Nacker and Examiner Thomas on 22 August 2001, have elected to have the allowable claims submitted in independent form by way of amendment in parent application 09/283,100 and those claims requiring additional searching to be presented in the instant application by way of Preliminary Amendment.

To assist the Examiners in their further searching, Applicants submit herewith a copy of the "Draft Amendment" that was discussed at the 16 August 2001 interview, a copy of the Interview Summary of 16 August 2001, and copies of the PTO-892 forms "Notice of References Cited" listing references cited of record in the 09/283,100 case. The claims, as currently submitted, are believed free of this art.

Prompt searching of and action on the currently submitted claims is courteously requested.

Respectfully submitted,



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Date: 27 August, 2001

Attachment
Newly Added Claims

--37. (New) A layered structure for forming a thin layer capacitor comprising a metal foil formed of a metal selected from the group consisting of copper, zinc, nickel, iron, niobium, molybdenum, titanium, nickel/chromium alloy, iron/nickel/chromium alloy and aluminum, and a dielectric material deposited on the foil, wherein the dielectric material is a layer having a thickness of from about 0.03 to about 2 microns, said metal foil having an exposed surface and said dielectric material layer having an exposed surface.

38. (New) The layered structure of Claim 37 wherein said dielectric material contains between about 1 wt% and about 100 wt% silica.

39. (New) The layered structure of Claim 37 wherein said metal foil is selected from the group consisting of copper foil, nickel foil and aluminum foil.

40. (New) The layered structure according to Claim 37 said second metal layer is a metal layer deposited on said dielectric material layer.

41. (New) The layered structure according to Claim 40 wherein said foil is between about 12 and about 110 microns.

42. (New) The layered structure according to Claim 37 wherein said dielectric material layer is selected from the group consisting of BST, SrTiO₃, Ta₂O₅, TiO₂, MnO₂, Y₂O₃, SnO₂, and PLZT.

43. (New) The layered structure according to Claim 37 wherein said dielectric material layer is selected from the group consisting of barium titanium oxide, zirconium-doped barium titanium oxide, and tin-doped barium titanium oxide.

44. (New) The layered structure according to Claim 37 wherein said dielectric material layer is selected from the group consisting of WO₃, SrO, mixed tungsten strontium oxides, and BaWO₄.

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Attachment
Newly Added Claims

45. (New) The layered structure according to Claim 37 wherein said dielectric material is an oxide or mixed oxide that contains an element selected from the group consisting of Ti, Ta, Nb, Zr, W, Mo, and Sn.

46. (New) The layered structure in accordance with Claim 37 wherein said first metal layer has a surface roughness on the side of said dielectric material layer of at least about $1.1 \text{ cm}^2/\text{cm}^2$.

47. (New) The layered structure in accordance with Claim 37 wherein said dielectric material layer is lossy having an electrical conductivity value of from about 10^{-1} to about 10^{-5} amperes per cm^2 .

48. (New) A layered structure for acting as or forming at least one thin layer capacitor comprising, in sequence, a first metal layer selected from the group consisting of copper, zinc, nickel, iron, niobium, molybdenum, titanium, nickel/chromium alloy, iron/nickel/chromium alloy and aluminum, a dielectric material deposited on the first metal layer and having a thickness of from about 0.03 to about 2 microns and wherein the dielectric material contains a cation other than that of the metal from which the metal foil is formed, and a second metal layer, said first and second metal layers each having an exposed surface.

49. (New) The layered structure of Claim 48 wherein said dielectric material contains between about 1 wt% and about 100 wt% silica.

50. (New) The structure according to Claim 48 wherein said first metal layer is a foil.

51. (New) The layered structure of Claim 48 wherein said metal foil is selected from the group consisting of copper foil, nickel foil and aluminum foil.

52. (New) The layered structure according to Claim 48 wherein said first metal layer is a metal foil and said second metal layer is a metal layer deposited on said dielectric material layer.

53. (New) The layered structure according to Claim 52 wherein said foil is between about 12 and about 110 microns thick and said second metal layer is between about 0.5 and about 3 microns thick.

Attachment
Newly Added Claims

54. (New) The layered structure according to Claim 48 wherein said first metal layer is a coating between about 0.5 and about 3 microns thick on a polymeric support sheet.

55. (New) The layered structure according to Claim 48 wherein said dielectric material layer comprises between about 1 wt% and 100 % silica.

56. (New) The layered structure according to Claim 48 wherein said dielectric material layer is selected from the group consisting of BST, SrTiO₃, Ta₂O₅, TiO₂, MnO₂, Y₂O₃, SnO₂, and PLZT.

57. (New) The layered structure according to Claim 48 wherein said dielectric material layer is selected from the group consisting of barium titanium oxide, zirconium-doped barium titanium oxide, and tin-doped barium titanium oxide.

58. (New) The layered structure according to Claim 48 wherein said dielectric material layer is selected from the group consisting of WO₃, SrO, mixed tungsten strontium oxides, and BaWO₄.

59. (New) The layered structure according to Claim 48 wherein said dielectric material is an oxide or mixed oxide that contains an element selected from the group consisting of Ti, Ta, Nb, Zr, W, Mo, and Sn.

60. (New) The layered structure in accordance with Claim 48 wherein said first metal layer has a surface roughness on the side of said dielectric material layer of at least about 1.1 cm²/cm².

61. (New) The layered structure in accordance with Claim 48 wherein said dielectric material layer is lossy having an electrical conductivity value of from about 10⁻¹ to about 10⁻⁵ amperes per cm².

62. (New) A layered structure for forming a thin layer capacitor comprising:

a flexible polymer support sheet,

an un-patterned first metal layer formed on said flexible polymer support sheet, said first metal layer being release-able from said support sheet, the metal being selected from the group

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Attachment
Newly Added Claims

consisting of copper, zinc, nickel, iron, niobium, molybdenum, titanium, nickel/chromium alloy, iron/nickel/chromium alloy and aluminum,

a dielectric layer formed on said un-patterned first metal layer between about 0.03 and about 2 microns thick, and

a second metal layer formed on said flexible polymer support sheet, the metal being selected from the group consisting of copper, zinc, nickel, iron, niobium, molybdenum, titanium, nickel/chromium alloy, iron/nickel/chromium alloy and aluminum, said second metal layer having an exposed surface.

63. (New) The layered structure of Claim 62 wherein said dielectric material contains between about 1 wt% and about 100 wt% silica.

64. (New) The layered structure according to Claim 62 wherein said dielectric material layer is selected from the group consisting of BST, SrTiO₃, Ta₂O₅, TiO₂, MnO₂, Y₂O₃, SnO₂, and PLZT.

65. (New) The layered structure according to Claim 62 wherein said dielectric material layer is selected from the group consisting of barium titanium oxide, zirconium-doped barium titanium oxide, and tin-doped barium titanium oxide.

66. (New) The layered structure according to Claim 62 wherein said dielectric material layer is selected from the group consisting of WO₃, SrO, mixed tungsten strontium oxides, BaWO₄, CeO₂, and Sr_{1-x}Ba_xWO₄.

67. (New) The layered structure in accordance with Claim 62 wherein said first metal layer has a surface roughness on the side of said dielectric material layer of at least about 1.1 cm²/cm².

68. (New) The layered structure in accordance with Claim 62 wherein said dielectric material layer is lossy having an electrical conductivity value of from about 10⁻¹ to about 10⁻⁵ amperes per cm².--

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Hunt et al.

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Serial No.: 09/283,100

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Filed: March 31, 1999

: Group Art Unit: 2831

For: FORMATION OF THIN FILM CAPACITORS

: Examiner: E. Thomas

AMENDMENT, After final

Assistant Commissioner of Patent and Trademarks
US Patent and Trademark Office
Washington, DC 20231

In response to the Official Action mailed on 1 June 2001, Applicants submit the following amendments and remarks.

In the Claims

Claim 5, line 2, change "metal" (second instance) to -copper--.

Claim 6, line 1, change the dependency from "5" to -35--.

Cancel Claims 8 and 9 and Claims 24-28.

Amend Claim 29 and 35 to read as follows:

29. (Amended) A layered structure for forming a thin layer capacitor comprising a metal foil formed of a metal selected from the group consisting of copper, zinc, nickel, iron, niobium, molybdenum, titanium, nickel/chromium alloy, iron/nickel/chromium alloy and aluminum, and a dielectric material deposited on the foil, wherein the dielectric material is a layer having a thickness of from about 0.03 to about 2 microns, said metal foil having an exposed surface and said dielectric material layer having an exposed surface.

35. (amended) A layered structure for acting as or forming at least one thin layer capacitor comprising in sequence a first metal layer selected from the group consisting of copper,

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zinc, nickel, iron, niobium, molybdenum, titanium, nickel/chromium alloy, iron/nickel/chromium alloy and aluminum, a dielectric material deposited on the first metal layer and having a thickness of from about 0.03 to about 2 microns and wherein the dielectric material contains a cation other than that of the metal from which the metal foil is formed, and a second metal layer, said first and second metal layers each having an exposed surface.

Add Claims 36-46 which reads as follows:

--36. The layered structure according to Claim 35 wherein said second metal layer is patterned.

37.. A layered structure for forming a thin layer capacitor comprising:

a flexible polymer support sheet,

an un-patterned first metal layer formed on said flexible polymer support sheet, said first metal layer being release-able from said support sheet, the metal being selected from the group consisting of copper, zinc, nickel, iron, niobium, molybdenum, titanium, nickel/chromium alloy, iron/nickel/chromium alloy and aluminum,

a dielectric layer formed on said un-patterned first metal layer between about 0.03 and about 2 microns thick, and

a second metal layer formed on said flexible polymer support sheet, the metal being selected from the group consisting of copper, zinc, nickel, iron, niobium, molybdenum, titanium, nickel/chromium alloy, iron/nickel/chromium alloy and aluminum, said second metal layer having an exposed surface.

38. The layered structure according to Claim 37 wherein said support sheet is polymeric material.

39. The layered structure according to Claim 37 wherein said second metal layer is patterned..

40. A layered structure for acting as or forming at least one thin layer capacitor comprising in sequence a first metal layer selected from the group consisting of copper, zinc, nickel, iron, niobium, molybdenum, titanium, nickel/chromium alloy, iron/nickel/chromium alloy and aluminum, a dielectric material deposited on the first metal layer and having a thickness of from about 0.03 to about 2, a second metal layer, and a barrier lalyer between about 0.01 and about 0.08 microns thick between said first metal layer and said dielectric material layer.

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41. The layered structure according to Claim 40 wherein said barrier layer is formed of material selected from the group consisting of tungsten oxide, strontium oxide, and mixed tungsten/strontium oxides.
42. The layered structure according to Claim 40 wherein said barrier layer is formed of material selected from the group consisting of BAWO_4 , silica, alumina, nickel and platinum.
43. The layered structure according to Claim 40 wherein said barrier layer is formed of material selected from the group consisting of ceria and $\text{Sr}_{1-x}\text{Ba}_x\text{WO}_4$.
44. A layered structure for acting as or forming at least one thin layer capacitor comprising in sequence a first metal layer selected from the group consisting of copper, zinc, nickel, iron, niobium, molybdenum, titanium, nickel/chromium alloy, iron/nickel/chromium alloy and aluminum, a dielectric material deposited on the first metal layer and having a thickness of from about 0.03 to about 2 microns, a second metal layer, and an adhesion layer between about 0.0001 and about 0.05 microns thick between said dielectric material layer and said second metal layer.
45. The layered structure according to Claim 44 wherein said adhesion layer is a functionally gradient material..
46. A layered structure for acting as or forming at least one thin layer capacitor comprising in sequence a first metal layer selected from the group consisting of copper, zinc, nickel, iron, niobium, molybdenum, titanium, nickel/chromium alloy, iron/nickel/chromium alloy and aluminum, a dielectric material deposited on the first metal layer and having a thickness of from about 0.03 to about 2 microns, and a second metal layer, said dielectric material layer being chemically doped to be lossy having an electrical conductivity value of from about 10^{-1} to about 10^{-5} amperes per cm^2 .

REMARKS

Claims 2-3, 5-35 are pending in the present application. Claims 8, 9, and 24-28 are deleted with this amendment; Claims 36-46 are added with entry of this Amendment.

Claims 40, 44, and 46 correspo

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nd, respectively, to previously considered claims 10, 14, and 26 that the Examiner deemed patentable if rewritten in independent form. These claims, and the claims dependent from these claims, are submitted to be allowable.

The present invention provides materials that can be used, **universally**, by makers of printed circuit boards to provide embedded capacitor structures. In its simplest form, such materials comprise a two-layer laminate of a metal foil and a thin layer dielectric material. This is recited in independent Claim 29. To this can be added a second metal layer to form a three-layer laminate as recited in Claim 35. In the two-layer laminate a surface of the foil layer and a surface of the dielectric are exposed. In the three-layer laminate, a surface of each metal layer is exposed. Exposure of these surfaces are now recited in amended Claims 29 and 35. Support for the language "exposed surfaces" is found in the circuitization method described in reference to Figures 4A-4C.

Claims 29 and 35, as amended, are neither anticipated nor obvious from Laufer et al. (5,027,253). Laufer et al. describe a device that incorporates embedded capacitors, but in no way does it describe a material that can be universally used by printed circuit board manufacturers. Specifically, it describes neither a two-layer laminate having two exposed surfaces that can be universally used (circuitized to the requirements of the manufacturer), nor a three layer laminate that can be universally used.

In Laufer (See the flow chart of Fig. 1 and the Example), a metal foil is laminated to a PTFE support and this foil layer is **circuitized**. On this is deposited a dielectric layer, and then a second metal layer. The circuitization of the first metal layer **is specific to the device, but precludes its universal use**.

Accordingly, Claims 29 and 35, and the claims depending from each of these independent claims are believed to be allowable.

Newly submitted Claim 37 is directed to another laminate universally useful for forming printed circuit board. To a polymeric support is deposited a first metal layer, a dielectric layer, and a second dielectric layer having an exposed surface. The first metal layer is un-patterned (as opposed to the patterned first metal layer in Laufer et al.) and is releasable from the polymeric support sheet. After the second metal layer is patterned, it is embedded in support material, such

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as epoxy pre-preg. Then the polymeric support sheet is removed from the first metal layer, allowing the first metal layer to be patterned.

In view of the recitations that apply to the universal applicability of the Claim 37 structure and distinguish over Lauffer et al., Claim 37 and Claims 38 and 39, depending therefrom are believed to be allowable.

All of the claims are believed to be in condition for allowance. Favorable action is courteously requested.

Respectfully submitted,

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